MINERALOGY OF THE MARTIAN NORTH POLAR SAND SEA FROM 1995 HUBBLE SPACE TELESCOPE NEAR-IR OBSERVATIONS. J.F. Bell III[1], P.C. Thomas[1], M.J. Wolff[2], S.W. Lee[3], and P.B. James[4], [1]Cornell University, Dept. of Astronomy, Ithaca NY 14853: email jimbo@marswatch.tn.cornell.edu, [2]Space Science Institute, Boulder CO 80303, [3]University of Colorado, LASP, Boulder, CO 80309, [4]University of Toledo, Dept. of Physics and Astronomy, Toledo, OH 43606.

SYNOPSIS

Multispectral images of Mars obtained from the Hubble Space Telescope during 1995 have provided the first calibrated, high spatial resolution measurements of unfrosted north polar terrains in the near-infrared (750 to 1050 nm). The images reveal that the dark, circumpolar annulus has a 25-30% deep absorption feature near 953 nm. This band is one of the strongest mineralogic absorption features yet detected on Mars. Because the band appears to be centered near 953 nm as opposed to 860 nm or >1000 nm, we interpret its most likely origin as an Fe^{2+} feature in a low-Ca pyroxene. However, alternate possibilities such as a different pyroxene chemistry or the presence of various ferric phases, cannot be entirely discounted. We believe that the strength of the band is probably the result of coarser particle sizes and a more confined particle size range related to the known occurrence of sand dunes in this part of Mars. Alternate possibilities that may explain some or all of this effect include increased pyroxene abundances, variations in pyroxene chemistry that could lead to increased band depths, or less Fe^{3+} oxidative weathering in this surface region.

OBSERVATIONS

During July and August 1995 the Hubble Space Telescope (HST) obtained 9-filter multispectral CCD images of Mars as part of a long-term synoptic monitoring program [1, 2]. The observations were designed to augment the earlier HST 5-filter UV to visible observing program by providing additional measurements in the near-IR at wavelengths diagnostic of ferric and ferrous minerals [3,4]. Images were obtained with the Wide Field/Planetary Camera 2 (WFPC2) in 7 filters with the PC chip (255, 336, 410, 502, 673, 953, and 1042 nm) and at 2 linear ramp filter positions with WF chip 4 (740, 860 nm). The observations were obtained when Mars subtended only 4.8 to 5.6 arcsec, and thus the sub-Earth point spatial resolution for the PC images is 55-60 km/pixel and for the WF images is 110-120 km/pixel. The spatial resolution in the polar regions is typically 100-200 km/pixel. The season on Mars at this time was mid northern

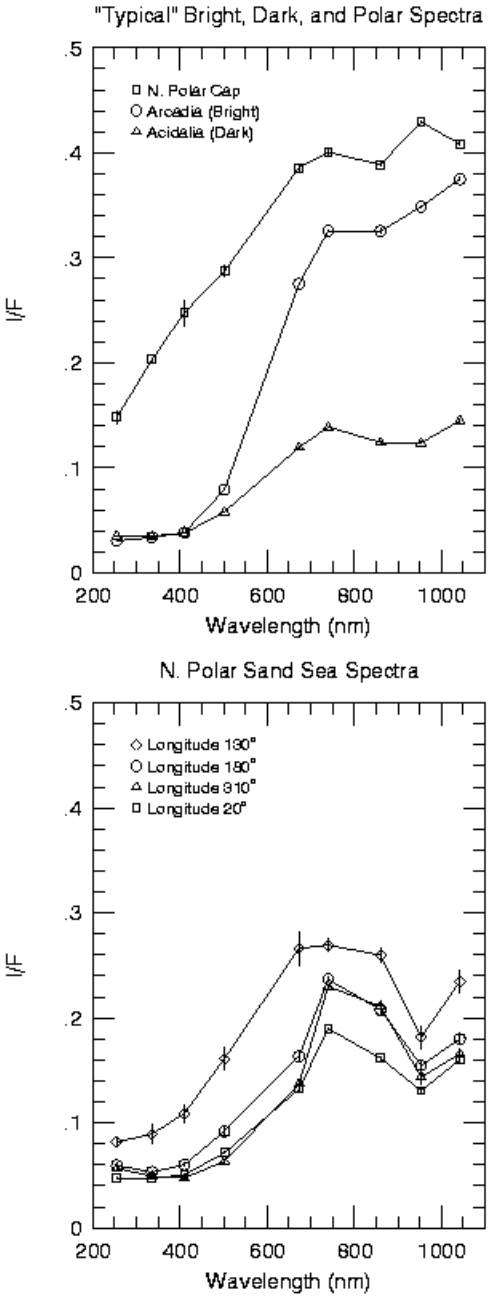

Figure 1: Spectra extracted from the 6 July 1995 HST image cube. (Top) Typical bright, dark, and polar cap spectra. (Bottom) Spectra extracted from several longitudes along the dark circumpolar annulus near 85°N.

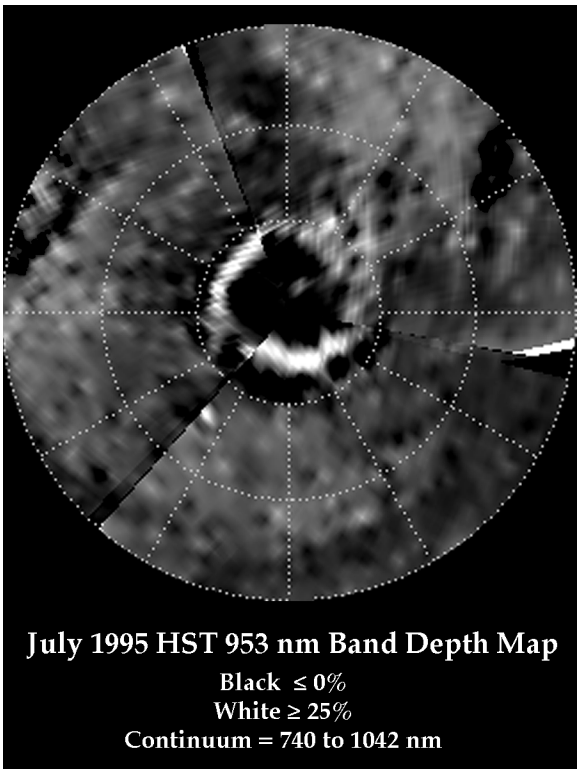

Figure 2: Polar stereographic projection of 953 nm band depth map generated from 6 July 1995 HST image cube. Map edge is 45°N and 0° longitude is at the top; latitude grid marks are 15° and longitude grid marks are 30°.

summer L_s=122° to 145°), and the Earth-Mars viewing geometry offered very favorable views of the northern polar regions (Sub-Earth latitude = 26°). Because Mars is always quite distant from the Earth during its northern summer season, groundbased observations during this season cannot provide very high spatial resolution. The Viking Orbiters did not obtain near-IR data and Phobos-2 only obtained data at equatorial latitudes, so these HST images are the first high-quality, calibrated measurements of these surface regions in the near-IR. The HST data in the near-UV and visible also substantially extend the time base for these types of measurements.

RESULTS

We calibrated the HST images to I/F [5] and then coregistered the data into a polar stereographic map projected image cube. We then extracted spectra from the image cube to search for anomalous spectral units. Typical bright, dark, and polar cap regions show good agreement with previous groundbased spectroscopic results (Figure 1, top). The most interesting regions that we found were associated with the dark circumpolar annulus. Spectra of these regions (Figure 1, bottom) appear similar to spectra of typical dark regions, except for a strong decrease in radiance factor in the 953 nm filter. In order to better visualize this spectral feature we constructed a band depth map [5,6] of the 953 nm absorption relative to a continuum defined by the 740 nm and 1042 nm images. The resulting band depth map (Figure 2) shows that the regions of enhanced 953 nm absorption correlate directly with areas mapped as dune fields from Viking Orbiter imagers [7,8]. The region also shows a good, though not perfect, correlation with regions of lower polar thermal inertia as presented by [9]. We are continuing to explore correlations between this region of enhanced band depth with geology, albedo, and topography in order to more accurately constrain its origin. Currently, we believe that the most likely interpretation of the results in Fig. 2 is that coarser grain sizes and a more uniform particle size distribution are leading to an enhancement in the depth of the pyroxene band in the dark, basaltic polar dune deposits.

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